HHS Public Access

Author manuscript

J Asthma. Author manuscript; available in PMC 2021 June 01.

Published in final edited form as:

J Asthma. 2020 June ; 57(6): 593–600. doi:10.1080/02770903.2019.1594890.

Asthma self-management education in persons with work-related asthma – United States, 2012–2014

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Abstract

Objective: According to the National Asthma Education and Prevention Program (NAEPP), self-management education is an integral component of effective asthma care and should be offered to every patient with asthma. To estimate the proportion of persons with work-related asthma (WRA) who received asthma self-management education.

Methods: A cross-sectional analysis of 2012–2014 Behavioral Risk Factor Surveillance System Asthma Call-back Survey data was conducted among ever-employed adults (≥18 years) with current asthma from 31 states and the District of Columbia.

Results: Adults with WRA were significantly more likely than those with non-WRA to have ever taken a course to manage their asthma (15.7% versus 6.5%; PR = 2.1), been given an asthma action plan (43.5% versus 26.1%; PR = 1.7), shown how to use an inhaler (97.2% versus 95.8%; PR = 1.0), taught how to recognize early symptoms of an asthma episode (79.4% versus 64.1%; PR = 1.2), taught what to do during an asthma episode (86.4% versus 76.3%; PR = 1.1), taught how to use a peak flow meter to adjust daily medications (57.9% versus 41.7%; PR = 1.3), and advised to change things in home, school, or work (56.9% versus 30.4%; PR = 2.0). Moreover, targets for corresponding Healthy People 2020 respiratory disease objectives were met only among adults with WRA.

Conclusions: Although adults with WRA were more likely to have received asthma self-management education, results suggest missed opportunities to provide asthma self-management education. Every healthcare visit should be used as an opportunity to discuss asthma self-management.

Keywords

WRA; occupational health; NAEPP; BRFSS; ACBS

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Declaration of interest

The findings and conclusions in this report are those of the authors and do not necessarily represent the official views of the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention (CDC).

The authors report no conflicts of interest.

Introduction

Self-management education is one of four key components of effective asthma care recommended by the National Asthma Education and Prevention Program (NAEPP) and should be offered to every patient with asthma at all points of care (1). Moreover, a Healthy People 2020 respiratory disease objective focuses on increasing the proportion of persons who receive appropriate asthma self-management education according to the NAEPP guidelines (1,2). Evidence suggests that asthma self-management education is effective in improving asthma control, reducing exacerbations and healthcare utilization, and improving quality of life (3). Nonetheless, some adults with asthma are not receiving recommended asthma self-management education (4). Persons with asthma caused or worsened by workplace exposures (i.e., work-related asthma [WRA]) have more frequent and severe asthma symptoms and greater asthma-related healthcare utilization than those with non-WRA (5,6). Proper education and management of WRA are important and may reduce exacerbations, decrease use of medical resources, and help patients anticipate and respond to symptoms in relation to their work environment (5–8).

Selected topic areas of the NAEPP guidelines are currently under revision (9,10). Moreover, to our knowledge, there is no population-based information available on receipt of asthma self-management education in persons with WRA. Therefore, to inform new guidelines and future studies, the objective of the study was to estimate the proportion of persons who received asthma self-management education, stratified by WRA status, using the most currently available Behavioral Risk Factor Surveillance System (BRFSS) Asthma Call-back Survey (ACBS) data (2012–2014) for ever-employed adults with current asthma from 31 states and the District of Columbia (DC). Additionally, we examined factors associated with receiving asthma self-management education among persons with WRA.

Methods

BRFSS is an ongoing, random-digit-dialed telephone survey of the non-institutionalized U.S. population aged ≥18 years. BRFSS respondents who answered “yes” to the question “Have you ever been told by a doctor or other health professional that you have asthma?” were invited to participate in the ACBS. Those who consented were called back within two weeks and asked detailed questions about their asthma, including receipt of asthma self-management education. Survey methodology has been described in detail elsewhere (11,12). The American Association for Public Opinion Research median response rates among the 31 states and DC providing data for this report ranged from 44.0% in 2013 to 46.0% in 2014 for BRFSS and 46.0% in 2013 to 47.3% in 2012 for the ACBS (11,12). A surveillance exemption has been granted for BRFSS from the Institutional Review Board at the Centers for Disease Control and Prevention. Participating states are subject to their state-specific Institutional Review Board requirements.

Respondents who indicated they were currently “employed full time” or “employed part-time” or had ever been employed were considered to be ever-employed. Adults with current asthma, WRA, and possible WRA were identified by affirmative responses to the questions

shown in Table 1. Persons who did not have WRA or possible WRA were considered to have non-WRA.

Lastly, the ACBS asks questions corresponding to the asthma self-management education recommendations in the NAEPP Expert Panel Report-3 (9). Respondents' asthma self-management education was ascertained using responses to seven questions about having ever been taught an asthma management course, given an action plan, taught inhaler use, taught to recognize early symptoms of an asthma episode, taught what to do during an asthma episode, taught how to use a peak flow meter, and advised to change things in their home, school, or work (Table 1).

Statistical analysis

Analyses were performed in 2018 using SAS version 9.4 (SAS Institute Inc., Cary, NC) and SUDAAN release 11.0.1 (Research Triangle Institute, Research Triangle Park, NC) survey procedures. Landline and cellular telephone household data for the 31 states and DC from 2012–2014 were combined and weighted to increase reliability and precision of estimates and to produce estimates representative of the state populations. Weights used for analyses were established by multiplying the percentage of subjects in each state and survey year by the corresponding survey year's weight.

The proportion of persons who received each form of asthma self-management education was estimated among ever employed adults with current asthma, WRA, possible WRA, and non-WRA. We calculated adjusted prevalence ratios (PRs) using multivariate logistic regression to examine whether individuals with WRA and possible WRA differed from those with non-WRA in the administration of asthma self-management education. Lastly, we examined factors associated with each form of asthma self-management education among individuals with WRA by fitting multivariate logistic regression models to estimate PRs. Age, sex, education level, household income, health insurance, and current employment status were significantly associated with WRA or asthma self-management education and were simultaneously included in all multivariate logistic regression models. Race/ethnicity was kept in the model regardless of statistical significance because of its importance in considering asthma self-management education (4). Estimates with a relative standard error (i.e., standard error divided by the estimate) >30% or based on a sample of <50 respondents were not reported (12).

Results

During 2012–2014, a total of 32,470 adults ever diagnosed with asthma participated in the ACBS in 31 states and DC. Of these, 23,214 (representing an estimated annual average of 15 million persons) were ever-employed adults with current asthma. The remaining 9,256 participants did not have current asthma (n = 8,053), were never employed (n = 462), or had missing data on asthma or employment status (n = 741) and were excluded from analyses.

Among ever-employed adults with current asthma, an estimated 13.9% had WRA, 39.1% had possible WRA, and 47.1% had non-WRA (Table 2). In bivariate analysis, receiving at

least one self-management education element was significantly associated with age, sex, household income, health insurance, and asthma status.

Overall, 98.6% of ever-employed adults with current asthma received at least one form of asthma self-management education. By specific form, adults with WRA were significantly more likely than those with non-WRA to have ever taken a course to manage their asthma (15.7% versus 6.5%; PR = 2.1), been given an asthma action plan (43.5% versus 26.1%; PR = 1.7), shown how to use an inhaler (97.2% versus 95.8%; PR = 1.0), taught how to recognize early symptoms of an asthma episode (79.4% versus 64.1%; PR = 1.2), taught what to do during an asthma episode (86.4% versus 76.3%; PR = 1.1), taught how to use a peak flow meter to adjust daily medications (57.9% versus 41.7%; PR = 1.3), and advised to change things in home, school, or work (56.9% versus 30.4%; PR = 2.0) (Table 3). Adults with possible WRA were significantly more likely than those with non-WRA to have ever taken a course to manage their asthma (10.3% versus 6.5%; PR = 1.4) and advised to change things in home, school, or work (38.0% versus 30.4%; PR = 1.3).

When compared with the Healthy People 2020 targets, the proportion of persons with WRA who received each of the seven asthma self-management education forms exceeded targets set for each strategy. No target was met among persons with possible WRA or non-WRA (Table 3).

Results from the multivariate logistic regression analyses among persons with WRA are shown in Table 4. Each explanatory factor was associated with at least one of the forms of asthma self-management education except for household income; however, no clear pattern was observed. Those who had very poorly controlled asthma were significantly more likely to have ever taken a course to manage their asthma (PR = 1.67). Those who had an asthma attack in the 12 months prior to the interview were more likely to have ever been given an asthma action plan (PR = 1.30) and been advised to change things in their home, school, or work (PR = 1.20). Adults who had an asthma-related emergency room visit were more likely to have been taught how to use a peak flow meter to adjust their medications (PR = 1.23) and been advised to change things in their home, school, or work (PR = 1.20). Those who had an overnight stay in the hospital because of their asthma were more likely to have ever taken a course to manage their asthma (PR = 2.11), been taught how to recognize early signs of an asthma episode (PR = 1.14), what to do during an asthma episode (PR = 1.09), and to use a peak flow meter to adjust daily medication (PR = 1.33). Those who had urgent treatment for worsening asthma were significantly more likely to have received all forms of asthma self-management education except being shown how to use an inhaler. None of the explanatory factors assessed were significantly associated with being shown how to use an inhaler. Results from the multivariate logistic regression analyses among persons with possible WRA are shown in the supplemental materials (Supplementary Table S1).

Lastly, we assessed the association of WRA status with adverse asthma outcomes and asthma control by asthma self-management education and found no differences between those with and without each asthma self-management education component (Supplementary Table S2). Adults with WRA were more likely to experience poor asthma control and adverse asthma outcomes compared to adults with non-WRA regardless of receipt of asthma

self-management education. Due to small sample sizes, however, we were unable to make comparison to those who received none of the seven forms of asthma self-management education.

Discussion

Nearly all ever-employed adults with current asthma received at least one form of asthma self-management education during 2012–2014. Adults with WRA were more likely to have ever received each of the seven asthma self-management education forms. Moreover, all targets set for Healthy People 2020 respiratory disease objectives RD-6 and RD-7.1–7.8 were met only for adults with WRA (2). The greater severity of symptoms among adults with WRA and associated higher frequency of healthcare encounters may have resulted in health-care professionals being more likely to provide asthma self-management education to these patients to prevent asthma exacerbations and unscheduled visits (6,13).

According to the NAEPP guidelines, asthma self-management education is an integral component of effective asthma care and all adults with asthma should receive it (1). A web-based educational tool has been shown to improve knowledge of WRA and self-management strategies, which were retained for at least one year after the study, among asthma patients in a tertiary care clinic (14,15). To our knowledge, however, no previous reports have assessed receipt of national asthma guideline recommended management at a population level among patients with WRA. Results of this study for persons with non-WRA are consistent with a previous study among adults with active asthma that indicated limited receipt of national asthma guideline recommended management (4).

Cloutier et al. recently reported on the uptake of the guidelines among clinicians providing care to asthma patients. The authors found that, although a high proportion (73–95%) of primary care clinicians reported providing patient education regarding asthma symptom recognition, avoiding risk factors, inhaler use, and changing the home/work environment, they did so less frequently than asthma specialists (i.e., allergists and pulmonologists; 96–100%) (16). In this study, proportions of adults with WRA who were taught to recognize early symptoms of an asthma episode (79.4%), or were advised to change things in their home, school, or work (56.9%) are lower than would be expected based on the Cloutier et al. study results. Lack of healthcare providers' knowledge about the national guidelines, clinician's communication skills, lack of time during the patient visit, language barriers, access to specialist care, and patient health literacy and recall bias, may, in part, explain these differences (16–19).

Written asthma action plans are strongly recommended for patients with moderate or severe asthma, poorly controlled asthma, or a history of severe exacerbations, such as those with WRA (1,6). However, in this study, less than half of adults with WRA (43.5%) were given an asthma action plan. Results from the study by Cloutier et al. indicated that provision of a written asthma action plan was not strongly endorsed by primary care clinicians or asthma specialists, and may explain, in part, the low uptake (16).

An estimated 56.9% of adults with WRA were advised to change things in their home, school, or work, which exceeded the corresponding Healthy People 2020 goal (54.6%) (2). Because eliminating or reducing work-place triggers of asthma can prevent occupational asthma, improve asthma symptom control, and reduce health care costs, this should be considered first in the management of WRA and all adults with WRA should be assessed for possible workplace exposures and the need for workplace intervention (7,8).

Among adults with WRA, those with poorly controlled asthma and adverse asthma outcomes were more likely to have received several of the asthma self-management education components, suggesting that greater disease severity and higher frequency of healthcare utilization may be associated with receipt of asthma self-management education. Moreover, adults with WRA were more likely to experience poor asthma control and adverse asthma outcomes compared to adults with non-WRA regardless of receipt of asthma self-management education. However, due to the cross-sectional design of the survey, we were unable to determine if receipt of asthma self-management education preceded or followed adverse asthma outcomes. Additionally, no data were available to assess if asthma control improved after receipt of asthma self-management education. Evidence from previous studies supports the use of asthma self-management education at all points of care and demonstrates benefits such as reductions in asthma symptoms, severe asthma exacerbations, healthcare utilization, and death, as well as improvements in asthma outcomes, quality of life, and asthma control (1,20,21).

The findings in this report are subject to additional limitations. First, information on asthma and self-management education was self-reported and not validated by medical records or follow-up with healthcare providers. Second, no information on the point of care where health professionals or health educators interacted with patients was available. Third, no information was available to explain the reason for potential missed opportunities to provide asthma self-management education. Finally, because data are limited to 31 states and DC, the results might not be nationally representative or representative of nonparticipating states.

Conclusions

Although adults with WRA were more likely to have received asthma self-management education, less than half received asthma action plans and approximately half were advised to change their home, school, or work environments to improve their asthma, suggesting missed opportunities to provide recommended asthma self-management education. Every healthcare visit should be used as an opportunity to review current asthma symptoms and exacerbation history, identify and remove any barriers to effective asthma self-management, and ensure that every patient with current asthma has an asthma action plan.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

The authors thank the Behavioral Risk Factor Surveillance System state coordinators for their assistance in collecting the data used in this analysis. The authors also thank Dr. Michelle Cloutier, Department of Pediatrics, University of Connecticut Health and Connecticut Children's Medical Center, and Dr. Joy Hsu, National Center for Environmental Health, Centers for Disease Control and Prevention, for their helpful comments.

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Table 1.

Asthma Call-back Survey questions used in report.

Definition	Asthma Call-back Survey Question
Current asthma[a]	Have you ever been told by a doctor or other health professional that you have asthma?
	Do you still have asthma?
Work-related asthma[a]	Have you ever been told by a doctor or other health professional that your asthma was caused by, or your symptoms made worse by, any job you ever had?
Possible work-related asthma[a,b]	Are your asthma symptoms made worse by things like chemicals, smoke, dust or mold in your current job?
	Was your asthma first caused by things like chemicals, smoke, dust or mold in your current job?
	Were your asthma symptoms made worse by things like chemicals, smoke, dust or mold in any previous job you ever had?
	Was your asthma first caused by things like chemicals, smoke, dust or mold in any previous job you ever had?
Ever taken course/class to manage asthma[a]	Have you ever taken a course or class on how to manage asthma yourself?
Ever been given an asthma action plan[a]	Has a doctor or other health professional ever given you an asthma management plan?
Shown how to use an inhaler[a,c]	Did a doctor or other health professional show you how to use the inhaler?
Taught how to recognize early signs or symptoms of an asthma episode[a]	Has a doctor or other health professional ever taught you how to recognize early signs or symptoms of an asthma episode?
Taught what to do during an asthma episode or attack[a]	Has a doctor or other health professional ever taught you how to respond to episodes of asthma?
Taught how to use a peak flow meter to adjust daily medications[a]	Has a doctor or other health professional ever taught you how to use a peak flow meter to adjust your daily medications?
Advised to change things in home, school, or work to improve asthma[a]	Has a doctor or other health professional ever advised you to change things in your home, school, or work to improve your asthma?

[a] Response options include “yes” or “no”.

[b] An affirmative response to any of the four questions among adults who did not have work-related asthma.

[c] Among adults who have ever used an inhaler; 96.5% of ever-employed adults with current asthma had ever used an inhaler.

Table 2.

Characteristics of ever-employed adults with current asthma by asthma classification – 31 states[a] and DC, 2012–2014.

	All ever employed adults with current asthma				Proportion receiving at least one form of asthma self-management education	
Characteristics	**No. in Sample[b]**	**Weighted No.[c]**	**%[c]**	**(95% CI)**	**%[c]**	**(95% CI)**
Age group (years)[d]						
18–44	4,789	7,088,403	45.6	44.0–47.3	98.9	98.6–99.3
45–64	10,527	5,731,844	36.9	35.4–38.4	98.5	98.1 –98.9
≥ 65	7,805	2,710,744	17.5	16.5–18.4	98.0	97.2–98.8
Sex[d]						
Male	6,804	5,395,925	34.6	33.1 –36.2	98.2	97.6–98.8
Female	16,410	10,179,920	65.4	63.8–66.9	98.8	98.5–99.1
Race/Ethnicity						
White, non-Hispanic	18,513	10,690,120	69.5	67.8–71.3	98.6	98.3–98.9
Black, non-Hispanic	1,739	1,976,876	12.9	11.7–14.1	98.3	97.2–99.4
Hispanic	1,043	1,641,798	10.7	9.3–12.1	98.9	98.1 –99.7
Other, non-Hispanic	1,647	1,069,897	7.0	5.9–8.0	98.7	97.8–99.5
Education level						
≤ High school	8,193	5,761,212	37.0	35.4–38.6	98.4	98.0–98.9
> High school	14,996	9,804,571	63.0	61.4–64.6	98.7	98.4–99.0
Household income[d]						
< $25,000	8,126	5,000,728	35.7	34.0–37.3	98.1	97.5–98.7
$25,000–$49,999	5,056	3,062,100	21.8	20.5–23.2	98.8	98.2–99.3
≥ $50,000	7,776	5,954,392	42.5	40.8–44.2	99.0	98.6–99.4
Health insurance[d]						
Yes	21,180	13,398,505	86.2	84.9–87.5	98.8	98.5–99.0
No	1,997	2,146,112	13.8	12.5–15.1	97.7	96.7–98.7
Employment status						

Characteristics	All ever employed adults with current asthma				Proportion receiving at least one form of asthma self-management education	
	No. in Sample[b]	Weighted No.[c]	%[c]	(95% CI)	%[c]	(95% CI)
Currently employed	9,660	8,031,152	51.6	50.0–53.3	98.7	98.3–99.1
Not currently employed	13,514	7,520,289	48.4	46.7–50.0	98.5	98.2–98.9
Asthma status[d]						
WRA	3,498	2,155,902	13.9	12.8–14.9	99.4	98.9–100.0
Possible WRA	9,484	6,075,911	39.1	37.5–40.6	98.3	97.7–98.8
Non-WRA	10,179	7,326,152	47.1	45.4–48.8	98.6	98.3–99.0

CI: confidence interval; PR: prevalence ratio; WRA: work-related asthma.

[a]California, Connecticut, Georgia, Hawaii, Illinois, Indiana, Iowa, Maine, Maryland, Michigan, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Texas, Utah, Vermont, Washington, West Virginia, Wisconsin.

[b]Unweighted sample size.

[c]Weighted to provide average annual estimates using the survey sample weights for each participant.

[d]Rao-Scott chi-square test, $p < .05$.

Table 3.

Asthma self-management education among ever-employed respondents with current asthma, by work-related asthma status – 31 states[a] and DC, 2012–2014.

	All ever employed adults with current asthma		WRA		Possible WRA		Non-WRA		WRA versus non-WRA		Possible WRA versus non-WRA	
Asthma self-management education (Healthy People 2020 goal)	**%[b]**	**(95% CI)**	**%[b]**	**(95% CI)**	**%[b]**	**(95% CI)**	**%[b]**	**(95% CI)**	**PR[C]**	**(95% CI)**	**PR[C]**	**(95% CI)**
Ever taken course/class to manage asthma (14.5%)	9.2	8.3–10.2	15.7	12.8–18.5	10.3	8.7–11.8	6.5	5.3–7.7	**2.07**	**1.58–2.70**	**1.43**	**1.11–1.85**
Ever been given an asthma action plan (36.8%)	29.8	28.2–31.3	43.5	39.3–47.8	29.4	27.1–31.7	26.1	23.8–28.3	**1.68**	**1.47–1.91**	1.09	0.96–1.23
Shown how to use an inhaler[d,e]	95.8	95.2–96.4	97.2	96.1–98.2	95.4	94.6–96.2	95.8	94.8–96.9	**1.02**	**1.01–1.04**	1.00	0.99–1.02
Taught appropriate response to asthma episode[f] (68.5%)	66.6	65.1–68.2	78.6	75.4–81.9	65.0	62.6–67.5	64.4	62.0–66.9	**1.21**	**1.14–1.28**	1.00	0.95–1.06
Taught how to recognize early signs or symptoms of an asthma episode[e]	66.7	65.1–68.2	79.4	76.2–82.6	65.2	62.8–67.6	64.1	61.6–66.6	**1.24**	**1.17–1.32**	1.02	0.96–1.08
Taught what to do during an asthma episode or attack[e]	77.8	76.4–79.2	86.4	83.7–89.2	76.5	74.3–78.7	76.3	74.1–78.6	**1.14**	**1.09–1.19**	1.01	0.97–1.05
Taught how to use a peak flow meter to adjust daily medications[e]	45.5	43.8–47.1	57.9	53.7–62.1	45.6	43.2–48.1	41.7	39.2–44.3	**1.33**	**1.20–1.47**	1.06	0.97–1.16
Advised to change things in home, school, or work to improve asthma (54.6%)	37.0	35.5–38.6	56.9	52.8–61.0	38.0	35.6–40.4	30.4	28.1–32.7	**1.95**	**1.75–2.18**	**1.31**	**1.18–1.46**
Received at least one form of education	98.6	98.3–98.9	99.4	98.9–100.0	98.3	97.7–98.8	98.6	98.3–99.0	**1.01**	**1.00–1.02**	1.00	0.99–1.01

CI: confidence interval; PR: prevalence ratio; WRA: work-related asthma.

Note: Boldface indicates statistical significance ($p < .05$).

[a]California, Connecticut, Georgia, Hawaii, Illinois, Indiana, Iowa, Maine, Maryland, Michigan, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Texas, Utah, Vermont, Washington, West Virginia, Wisconsin.

[b]Weighted to provide average annual estimates using the survey sample weights for each participant.

[c]Prevalence ratio represents the probability of self-education among persons with WRA and possible WRA as compared with persons with non-WRA. For each model, the outcome variable was asthma self-education element and the predictor variable was WRA status adjusted for age, sex, race/ethnicity, education, household income, health insurance, and current employment status.

[d]Among adults who have ever used an inhaler; 96.5% of ever-employed adults with current asthma had ever used an inhaler.

[e]No corresponding Healthy People 2020 target.

[f]Corresponds to Healthy People 2020 objective RD-7.3: Persons who responded “yes” to being taught how to respond to an episode of asthma and either how to recognize early signs and symptoms of an asthma episode or how to monitor peak flow.

Table 4.

Multivariate association of asthma self-management education with select characteristics, asthma control, and adverse asthma outcomes among ever-employed adults with work-related asthma.

	Ever taken course/ class to manage asthma		Ever been given an asthma action plan		Shown how to use an inhaler[a]		Taught how to recognize early signs or symptoms of an asthma episode		Taught what to do during an asthma episode or attack		Taught how to use a peak flow meter to adjust daily medications		Advised to change things in home, school, or work to improve asthma	
Characteristics	**PR[b]**	**(95% CI)**	**PR[b]**	**(95% CI)**	**PR[b]**	**(95% CI)**	**PR[b]**	**(95% CI)**	**PR[b]**	**(95% CI)**	**PR[b]**	**(95% CI)**	**PR[b]**	**(95% CI)**
Age group (years)														
18–44	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
45–64	1.21	0.76–1.92	1.03	0.83–1.28	0.99	0.98–1.01	1.02	0.66–1.57	1.02	0.94–1.10	0.94	0.80–1.10	0.95	0.81–1.12
≥ 65	1.62	0.95–2.77	0.80	0.60–1.08	0.98	0.94–1.02	**1.63**	**1.02–2.61**	0.91	0.81–1.03	**0.79**	**0.63–0.98**	**0.67**	**0.52–0.86**
Sex														
Male	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Female	0.95	0.66–1.38	1.12	0.93–1.35	0.99	0.98–1.01	0.89	0.66–1.20	1.04	0.98–1.10	**1.25**	**1.07–1.45**	1.12	0.97–1.29
Race/Ethnicity														
White, non-Hispanic	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Black, non-Hispanic	**1.67**	**1.11–2.51**	1.14	0.87–1.50	1.00	0.98–1.03	1.15	0.63–2.10	0.86	0.71–1.03	1.11	0.91–1.37	0.82	0.62–1.09
Hispanic	1.34	0.71–2.54	0.91	0.62–1.34	1.00	0.96–1.03	0.98	0.47–2.04	0.98	0.83–1.14	0.85	0.60–1.19	1.00	0.75–1.33
Other, non-Hispanic	-		**1.51**	**1.08–2.11**	1.01	0.99–1.03	1.08	0.46–2.56	**1.10**	**1.06–1.14**	0.95	0.67–1.35	1.06	0.75–1.48
Education level														
≤ High school	0.96	0.66–1.41	0.96	0.80–1.16	0.99	0.97–1.01	**1.36**	**1.03–1.81**	**0.92**	**0.87–0.98**	1.06	0.93–1.21	0.95	0.83–1.10
> High school	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Household income														
< $25,000	0.93	0.57–1.51	1.11	0.86–1.42	1.00	0.97–1.04	0.70	0.44–1.10	1.06	0.95–1.19	1.11	0.90–1.35	0.92	0.76–1.13
$25,000–$49,999	1.18	0.72–1.93	1.22	0.95–1.58	1.02	0.99–1.04	0.70	0.42–1.15	1.10	0.99–1.22	1.20	0.99–1.45	1.01	0.83–1.23
≥ $50,000	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Health insurance														
Yes	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
No	1.28	0.79–2.07	**0.62**	**0.43–0.87**	1.00	0.97–1.02	1.23	0.74–2.04	0.97	0.89–1.06	0.87	0.70–1.09	0.95	0.75–1.20
Employment status														

Characteristics	Ever taken course/ class to manage asthma		Ever been given an asthma action plan		Shown how to use an inhaler[a]		Taught how to recognize early signs or symptoms of an asthma episode		Taught what to do during an asthma episode or attack		Taught how to use a peak flow meter to adjust daily medications		Advised to change things in home, school, or work to improve asthma	
	PR[b]	(95% CI)	PR[b]	(95% CI)	PR[b]	(95% CI)	PR[b]	(95% CI)	PR[b]	(95% CI)	PR[b]	(95% CI)	PR[b]	(95% CI)
Currently employed	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Not currently employed	**1.73**	**1.12–2.66**	1.16	0.95–1.42	1.00	0.98–1.02	0.91	0.62–1.35	1.01	0.93–1.09	1.15	0.98–1.35	1.02	0.87–1.20
Asthma control														
Well controlled	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Not-well-controlled	1.33	0.83–2.13	1.05	0.83–1.34	1.00	0.98–1.02	1.08	0.96–1.21	1.01	0.92–1.10	1.02	0.86–1.21	1.10	0.91–1.32
Very poorly controlled	**1.67**	**1.06–2.61**	1.15	0.91–1.45	1.00	0.97–1.02	1.07	0.96–1.19	1.02	0.95–1.10	0.98	0.82–1.17	1.14	0.95–1.37
Adverse asthma outcomes[c]														
Asthma attack														
Yes	1.11	0.76–1.64	**1.30**	**1.05–1.61**	1.00	0.98–1.03	1.11	1.00–1.23	1.06	0.99–1.13	1.16	1.00–1.36	**1.20**	**1.02–1.41**
No	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Urgent treatment for worsening asthma														
Yes	**1.49**	**1.04–2.13**	**1.25**	**1.05–1.50**	1.00	0.99–1.02	**1.18**	**1.09–1.27**	**1.11**	**1.04–1.18**	**1.26**	**1.10–1.44**	**1.20**	**1.04–1.38**
No	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Asthma-related emergency room visit														
Yes	1.22	0.82–1.84	1.15	0.94–1.40	0.99	0.97–1.02	1.05	0.96–1.16	1.05	0.97–1.14	**1.23**	**1.06–1.42**	**1.20**	**1.04–1.40**
No	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Overnight stay in hospital because of asthma														
Yes	**2.11**	**1.32–3.39**	1.20	0.93–1.55	0.98	0.93–1.02	**1.14**	**1.06–1.23**	**1.09**	**1.04–1.15**	**1.33**	**1.16–1.53**	1.18	0.99–1.42
No	1.00		1.00		1.00		1.00		1.00		1.00		1.00	

[a] Among adults who have ever used an inhaler; 96.5% of ever-employed adults with current asthma had ever used an inhaler.

[b] Prevalence ratio represents the probability of self-education among persons with the individual characteristic as compared with persons with no characteristic. For each model, the outcome variable was asthma self-education element and the predictor variable was the individual characteristic adjusted for age, sex, race/ethnicity, education, household income, health insurance, and current employment status.

[c] In the 12 months prior to the interview.

J Asthma. Author manuscript; available in PMC 2021 June 01.